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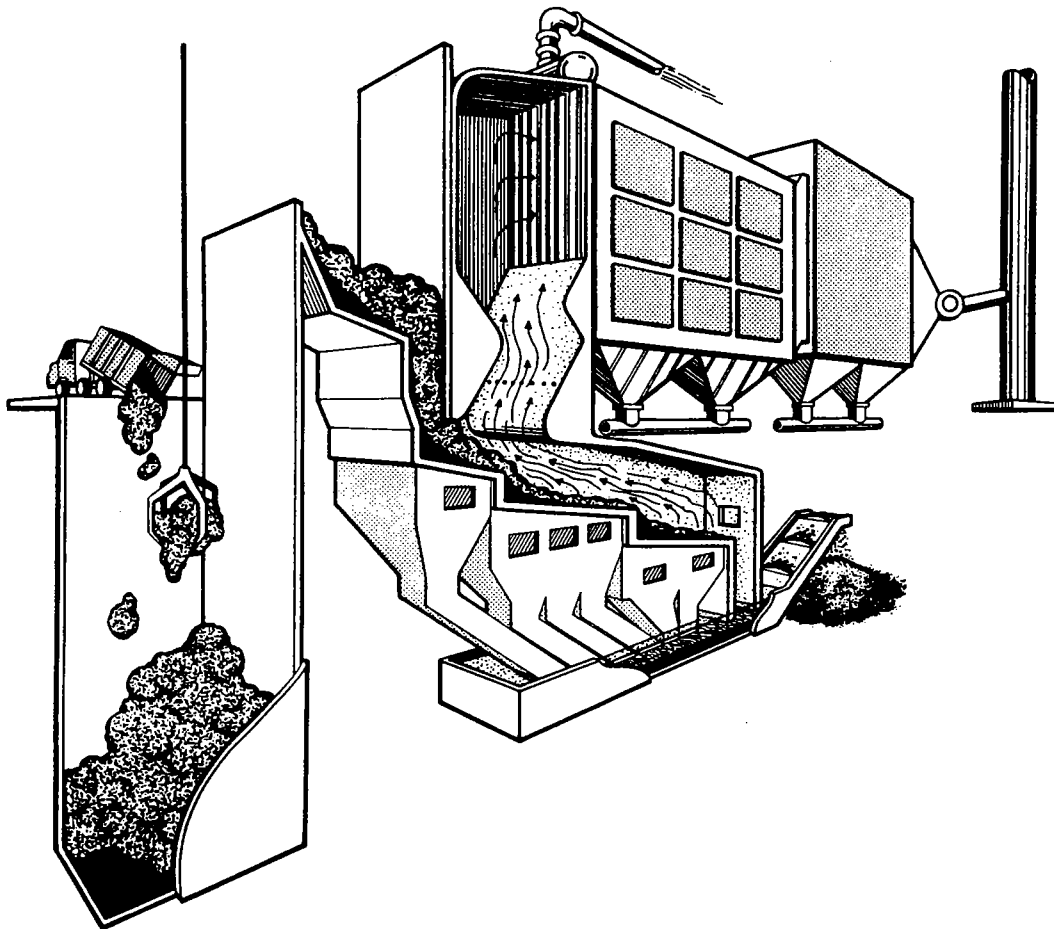
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# INCINÉRATION DES DÉCHETS MUNICIPAUX

LES 1<sup>er</sup> ET 2 OCTOBRE, 1987  
MONTRÉAL, QUÉBEC

# MUNICIPAL WASTE INCINERATION

OCTOBER 1-2, 1987  
MONTREAL, QUEBEC



Programme d'Essai et de l'Evaluation National des  
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AIR EMISSION TESTING  
AT THE COMMERCE REFUSE TO ENERGY FACILITY

By

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ABSTRACT

The Commerce Refuse to Energy Facility consists of a nominal 380 TPD mass-fired, water wall boiler which has been in operation since December 1986. The air pollution control equipment for the Facility includes Thermal DeNOx for NOx control plus a spray dryer and fabric filter for particulate and acid gas removal. An extensive 10-day test program was completed in late May and early June of 1987 as part of the requirements for a permit to operate from the South Coast Air Quality Management District. The test results for both the criteria pollutants and dioxin are among the lowest reported for a full-scale operating facility.

Introduction

The Commerce Refuse to Energy Facility is owned by a Joint Powers Authority consisting of the City of Commerce and the Los Angeles County Sanitation Districts (LACSD). The Facility is operated by the LACSD and combusts refuse collected within the City of Commerce which is predominantly from commercial accounts. The Facility was designed to minimize air emissions by employing combustion controls, Thermal DeNOx, a spray dryer and a fabric filter. The Facility construction was completed in late 1986 with the first firing of refuse in December 1986.

A comprehensive series of tests was conducted the last week of May and the first week of June 1987 to demonstrate compliance with the permit conditions of the South Coast Air Quality Management District (SCAQMD). The tests were performed by Energy Systems Associates in the presence of the SCAQMD and the California Air Resources Board (CARB). Additional, independent testing by the SCAQMD and CARB was performed during the second week.

All the testing, with the exception of the last day, was conducted with the boiler operating at full load on the normal refuse from the City of Commerce. The tests on the final day for dioxin were conducted with residential refuse from a neighboring city.

The test results demonstrate that the Facility produces very low levels of emissions which were well below the Permit requirements.

The following is a summary comparison of the permit requirements and the actual test results:

<u>Constituent</u>	<u>Permit Condition</u>	<u>Test Result</u>
NOx, PPM <sub>vd</sub> @ 3% O <sub>2</sub>	186	116
CO, PPM <sub>vd</sub> @ 3% O <sub>2</sub>	134	20
SO <sub>x</sub> , PPM <sub>vd</sub> @ 3% O <sub>2</sub>	29	1.7
Particulate, gr/dscf @ 12% CO <sub>2</sub>	.016	.0043

## Facility Description

The Facility consists of a single mass fired, water wall boiler as shown in Figure 1 which is designed to produce 115,000 pounds per hour of superheated steam at 750°F, 650 psig while combusting from 320 to 380 tons per day of refuse. The steam is used in a turbine to generate 11,400 KW of electrical power of which 10,000 KW is delivered to the local utility.

The refuse storage and receiving area is sized to accommodate 1,200 tons of refuse which is fed to a water cooled feed chute by overhead bridge cranes. The Detroit/Stoker grate system incorporates a ram feeder and three grate sections. The reciprocating grates are sloped at an angle of  $12\frac{1}{2}^{\circ}$  with a drop off between the grate sections to assist with breakup and mixing of the burning refuse.

The combustion air is drawn from the refuse storage building and supplied to the boiler by separate under grate and over fire fans. Manual dampers are provided to distribute the primary air to the three zones beneath the grates. A majority of the air is delivered to the center grate section. The air to the first section can be adjusted to condition or dry the refuse while the third section is used for final burnout of the refuse. The combustion air enters the furnace through holes in the front face of the grate bars in addition to passage up between the grate bars. The primary air is automatically varied by steam flow, increasing on lower than set point steam flow and decreasing for steam flow above the set point.

Secondary air is provided through over fire air ports located on both sides of the furnace and at two levels in the front and rear. Dampers are provided to adjust the air distribution to the various levels and the front and rear of the boiler.

The air pollution control system for the Facility consists of the Thermal DeNOx System, a spray dryer, and a fabric filter.

The Thermal DeNOx System utilizes compressed air as a carrier gas to inject ammonia through ports on both sides of the furnace. The ammonia is stored as a liquid under pressure and mixed as a vapor with compressed air prior to injection into the boiler.

At the economizer exit, the flue gas enters the spray dryer which utilizes a cyclone separator section to drop out flyash prior to the injection of a lime slurry through two-fluid nozzles. The spray dryer is designed to provide a ten-second residence time in the reactor vessel. After exiting the spray dryer, a dry powder is injected into the flue gas to assist in the conditioning of the fabric filter.

The fabric filter is a reverse air type consisting of eight separate modules. Each module contains 156 eight-inch diameter, fiberglass bags. The fabric filter is conservatively designed with an air to cloth ratio of 2:1 with one module off line for cleaning and one off line for maintenance. During normal operation with all modules on line, the air to cloth ratio of 1.5 to 1 allows for a thick filter cake which minimizes particulate emissions and provides secondary removal of acid gases.

The 2,3,7,8-TCDD toxic equivalents are presented in Table 8 using the California DOHS-Method IV, the EPA and the Swedish method. The results are presented based on the actual levels measured and also for the detection level. For the detection level, the detection limits were used in cases where the species were not detected. The measured values are based only on the quantities detected with a value of zero used for quantities below the detection limit.

The data support the previous finding that significant reductions in dioxin emissions are achieved with a spray dryer/fabric filter.

As a basis of comparison, the three tests average 2,3,7,8 toxic equivalent by the Swedish Method of  $.027 \text{ ng/Nm}^3$  at 12%  $\text{CO}_2$  for Commerce relates to a reported value of .155 for Marion County and .808 for Worzburg.

As evident from Table 7, however, reported values for toxic equivalents for modern plants may be more a function of detection limits than actual emissions.

#### Metals

Heavy metal measurements at the boiler exit and stack are presented in Table 8.

During laboratory analysis, a sample handling error was made by the lab. Prior to compositing the probe wash, filter, and impinger fractions for analysis, a 100 ml aliquot was erroneously taken from each probe wash fraction and discarded. Once the samples were composited, it was impossible to determine which fraction the metals in the samples came from.

Since liquid volumes of all of the sample fractions and of the discarded aliquots are known, it is possible to calculate ranges of results for each test. The lower range is based on the assumption that no metals were present in the probe wash and all of the metals were in the filter and impingers, and the upper range is based on the assumption that all of the metals were present in the probe wash. Non-volatile metals would be expected to be collected in the filter and probe wash fractions, which means that the true values for these metals are probably near the high ends of the ranges. The relatively volatile metals are probably near the high ends of the ranges. The relatively volatile metals (lead, arsenic, and especially mercury) would tend to be collected in the impingers, so that the true values for these metals probably lie closer to the low end of the ranges.

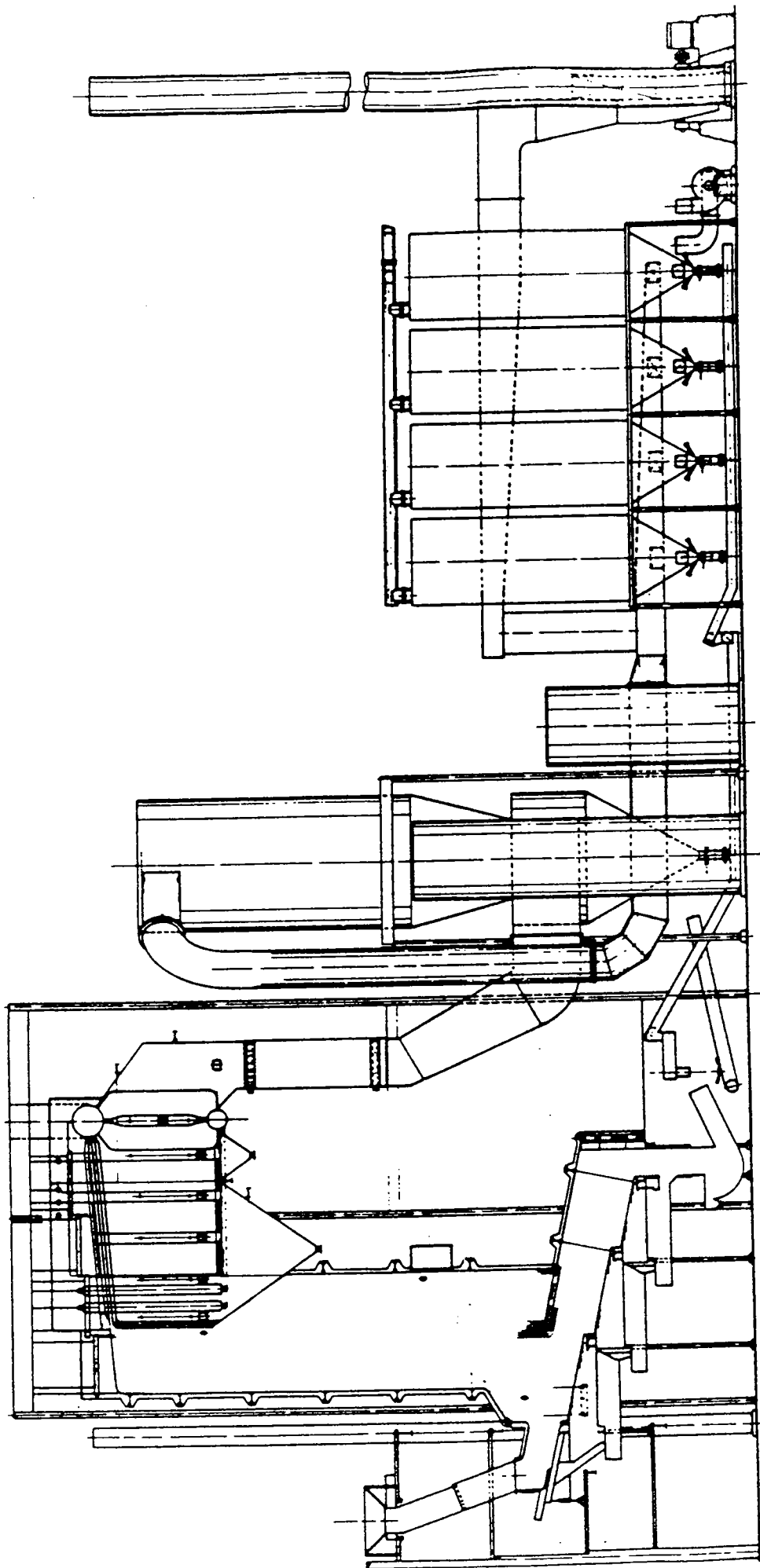


FIGURE 1  
COMMERCE REFUSE TO ENERGY FACILITY  
BOILER AND APC EQUIPMENT

TABLE 1

LIST OF EMISSION TESTS PERFORMED AT COMMERCE REFUSE-TO-ENERGY FACILITY  
(GROUPED BY TEST PROCEDURE)

Test No.	Type of Test	Sample Location	Date 1987	Sample Time	Steam Flow, lb/hr	Capacity Factor*	Comments
2-Stk-CEM	CEM**	Stack	5/27	0955-1100	118,000	1.03	NH <sub>3</sub> injection off High NH <sub>3</sub> PDS flask comparison
3-Stk-CEM	CEM	Stack	5/27	1120-1235	117,200	1.02	
4-Stk-CEM	CEM	Stack	5/27	1305-1425	118,300	1.03	
5-Stk-CEM	CEM	Stack	5/27	1525-1503	117,300	1.02	
6-Stk-CEM (no #)	CEM	Stack	5/27	1721-1750	115,600	1.01	
	CEM	Stack	5/27	1823-1845			
2-Stk-5	Particulate	Stack	5/27	0950-1120	118,000	1.03	NH <sub>3</sub> injection off
3-Stk-5	Particulate	Stack	5/27	1227-1355	117,200	1.02	
4-Stk-5	Particulate	Stack	5/27	1655-1810	117,100	1.02	
9-Stk-5	Particulate	Stack	5/29	0840-0940			
2-SE-5	Particulate	Scrubber exit	5/27	0943-1039	118,000	1.03	
3-SE-5	Particulate	Scrubber exit	5/27	1225-1330	117,200	1.02	
7-SI-17	Particulate	Scrubber inlet	5/28	1135-1306	116,500	1.01	
8-SI-17	Particulate	Scrubber inlet	5/28	1512-1643	118,900	1.03	
2-Stk-8	SO <sub>x</sub>	Stack	5/27	0954-1024	118,000	1.03	
3-Stk-8	SO <sub>x</sub>	Stack	5/27	1423-1453	116,500	1.01	
4-Stk-8	SO <sub>x</sub>	Stack	5/27	1825-1855	118,800	1.03	
7-SI-8	SO <sub>x</sub>	Scrubber inlet	5/28	1140-1215	116,500	1.01	
8-SI-8	SO <sub>x</sub>	Scrubber inlet	5/28	1516-1546	118,900	1.03	
11-Stk-CI	Part. sizing	Stack	6/1	0838-1438	113,100	0.98	
12-Stk-CI	Part. sizing	Stack	6/1	1612-2212	115,700	1.01	
11-Stk-MtIs	Metals	Stack	6/1	1140-1440	113,100	0.98	
13-Stk-MtIs	Metals	Stack	6/2	1020-1346	110,100	0.96	
13-SI-MtIs	Metals	Scrubber inlet	6/2	1225-1327	101,000	0.88	
14-SI-MtIs	Metals	Scrubber inlet	6/2	1550-1650			
15-Stk-HC1	HC1/HF/NH <sub>3</sub>	Stack	6/3	1100-1200	113,500	0.99	
16-Stk-HC1	HC1/HF/NH <sub>3</sub>	Stack	6/4	1225-1325	116,100	1.01	
15-SI-HC1	HC1/HF/NH <sub>3</sub>	Scrubber inlet	6/3	1100-1122	112,300	0.98	
16-SI-HC1	HC1/HF/NH <sub>3</sub>	Scrubber inlet	6/4	1227-1307	117,000	1.02	
15-Stk-SV	Semi-VOST	Stack	6/3	0859-1801	114,400	1.00	
16-Stk-SV	Semi-VOST	Stack	6/4	1411-1441	112,100	0.98	
17-Stk-SV	Semi-VOST	Stack	6/5	0845-1245	91,900	0.80	
17-SI-SV	Semi-VOST	Scrubber inlet	6/5	0845-1246	91,900	0.80	
16-Stk-HCx	Chlor. HC	Stack	6/4	1050-1112	109,500	0.95	3 samples
16-SI-HCx	Chlor. HC	Scrubber inlet	6/4	1152-1213	107,500	0.94	3 samples

\*Based on capacity of 115,000 lb/hr

\*\*CEM - Continuous Emissions Monitor for NO<sub>x</sub>, CO, O<sub>2</sub>

FIGURE 2

STACK NO<sub>x</sub> AND CO EMISSIONS  
 COMMERCE REFUSE TO ENERGY FACILITY  
 MAY 27, 1987

Test No. Sample Time	2-Stk-DEM 0955-1100	3-Stk-CEM 1120-1235	4-Stk-CEM 1305-1425	Avg. --	5-Stk-CEM 1525-1603	6-Stk-CEM 1721-1750
NH <sub>3</sub> /NO <sub>x</sub> *	1.45	1.45	1.45	1.45	0	2.0
NO <sub>x</sub> : ppm	68	64	69	67	121	48
ppm at 3% O <sub>2</sub>	120	112	116	116	199	80
CO: ppm	12	12	11	12	11	15
ppm at 3% O <sub>2</sub>	21	21	18	20	18	25

\*Based on NO<sub>x</sub> emission without NH<sub>3</sub> (Test No. 5-Stk-CEM)

TABLE 3

EMISSION DATA FOR  
 SO<sub>x</sub>, HCl, HF AND NH<sub>3</sub>

Average PPM at 3% O<sub>2</sub>, Dry

Location	Boiler Exit			Stack			
Test No.	7	8	Ave.	2	3	4	Ave.
SO <sub>2</sub>	405	194	300	1.49	1.29	1.89	1.56
SO <sub>3</sub>	57	47	52	.18	.15	.11	.15
SO <sub>x</sub>	462	241	352	1.67	1.44	2.00	1.70
Test No.	15	16	Ave.	15	16	Ave.	
HCl	1,389	914	1,152	14.3	8.4	11.35	
HF	19	21	20	.051	.046	.049	
NH <sub>3</sub>	--	--	--	2.06	3.17	2.67	

TABLE 4

PARTICULATE TEST RESULTS  
(GR/DSCF at 12% CO<sub>2</sub>)BOILER EXIT

Date	5/28	5/28	
Test No.	7-SI-17	8-SI-17	
Sample Time	1135-1306	1512-1643	Ave.
Solid	2.25	1.30	1.78
Condensable	<u>.34</u>	<u>.12</u>	<u>.23</u>
TOTAL	2.59	1.42	2.01

SCRUBBER EXIT

Date	5/27	5/27	
Test No.	2-SE-5	3-SE-5	
Sample Time	0943-1039	1225-1330	Ave.
Solid	2.84	2.43	2.64
Condensable	<u>--</u>	<u>--</u>	<u>--</u>
TOTAL	2.84	2.43	2.64

STACK

Date	5/27	5/27	5/27	Ave.	5/29
Test No.	2-Stk-5	3-Stk-5	4-Stk-5	With	9-Stk-5
Sample Time	0950-1120	1227-1355	1655-1810	NH <sub>3</sub>	0840-0940
NH <sub>3</sub> Feed	ON	ON	ON	FEED	OFF
Solid	.0022	.0043	.0022	.0029	.0019
Condensable	<u>.0029</u>	<u>.0006</u>	<u>.0008</u>	<u>.0014</u>	<u>.0037</u>
TOTAL	.0051	.0049	.0030	.0043	.0056

## PCDD/PCDF EMISSIONS FROM COMMERCE REFUSE-TO-ENERGY FACILITY

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Location Test	Concentration, ng/Mm <sup>3</sup> @ 12% CO <sub>2</sub>				
	Boiler Exhaust 17	Stack			Avg
		15	16	17	
2378-TCDD	ND<0.097*C	ND<0.003*C	ND<0.003*C	ND<0.003*C	ND<0.003
Total TCDD	0.865	0.033	0.032	0.27	0.112
12378-PCDD	0.097	ND<0.002	ND<0.001	ND<0.005*	ND<0.003
Total PCDD	0.448	0.011	0.011	0.130	0.051
123478-HxCDD	0.078	ND<0.003*	ND<0.001	0.005	<0.003
123678-HxCDD	0.124	ND<0.008*	ND<0.006*	ND<0.017*	ND<0.011
123789-HxCDD	0.124	ND<0.008*	ND<0.010*	0.015	<0.011
Total HxCDD	1.261	0.055	0.056	0.195	0.102
1234678-HpCDD	1.067	ND<0.058*	0.059	0.127	<0.081
Total HpCDD	2.16	0.062	0.059	0.254	0.125
OCDD	3.47	0.153	0.213	0.31	0.225
Total PCDD <sup>+</sup>	8.20	0.314	0.370	1.15	0.611
2378-TCDF	0.59C	ND<0.020*C	ND<0.024*C	ND<0.041*C	ND<0.028
Total TCDF	11.5	0.227	0.51	1.56	0.77
12378-PCDF	0.78	ND<0.003*	0.003	0.012	<0.006
23478-PCDF	0.51	ND<0.015*	ND<0.016*	0.051	<0.027
Total PCDF	2.83	0.059**	0.057	0.27	0.129
123478-HxCDF	0.64	0.03	0.016	0.056	0.034
123678-HxCDF	0.37	ND<0.012*	0.011	0.029	<0.052
234678-HxCDF	0.03	0.015	0.011	0.032	0.019
123789-HxCDF	ND<0.0006	ND<0.001	ND<0.001	ND<0.0005	ND<0.001
Total HxCDF	2.91	0.077	0.089	0.24	0.135
1234678-HpCDF	ND<0.0006	ND<0.001	ND<0.001	0.159	<0.054
1234789-HpCDF	0.156	ND<0.001	ND<0.0011	ND<0.008*	ND<0.003
Total HpCDF	2.18	0.086	0.075	0.22	0.127
OCDF	0.88	ND<0.032*	ND<0.041*	0.071	<0.048
Total PCDF <sup>+</sup>	20.3	0.480	0.771	2.36	1.20
Total PCDD/PCDF	28.5	0.794	1.14	3.51	1.82
Surrogate Recovery:					
13C12-TCDF	98.3%	97.7	104.0	92.8	98.1
37C1-TCDD	94.0%	101.1	103.2	95.3	99.9
13C12-HxCDF	90.4%	86.9	91.2	85.4	87.8

\* - EMPC (estimated maximum possible concentration; see Section 3.3.7)

\*\* - Ether interference

C - Confirmation result

+ - Sum of total values for Cl<sub>4</sub> thru Cl<sub>8</sub> subtotals, ND values are included in totals

## SEMI-VOST TEST INFORMATION

Sampling Method	CARB Modified Method 5 (Semi-VOST)
Analytical Method	GC/MS
Analytical Laboratory	Triangle Labs
Expected Levels	Less than 1 ng/m <sup>3</sup> (PCDD/PCDF) Less than 10 ng/m <sup>3</sup> (other compounds)
Analytical Lower Detection Limit	20-40 picograms for PCDD/PCDF tetra isomers; 40-80 picograms for PCDD/PCDF octa isomers; 1-10 nanograms for PAH, PCB, chlorobenzenes, chlorophenols
Sample Volumes	6 m <sup>3</sup> (4 or 8-hr sample)
Surrogate Spiking	Pre- and post test laboratory spikes using C <sup>13</sup> and C <sup>13</sup> PCDD/PCDF compounds
Blank	Full field blank train used
Fractions to be Analyzed	Probe wash, filter, sorbent module, connecting glassware rinse, and first impinger combined
Chain of Custody	Maintained by ESA and Triangle Labs on all samples
Sample Train Assembly and Recovery	Performed in on-site clean room to minimize chance of contamination
Glassware Cleaning	Acid cleaning followed by DI H <sub>2</sub> O, acetone, and hexane rinses and high temperature bake

TABLE 7

2,3,7,8 TCDD Toxic Equivalent Emissions  
ng/N<sub>m</sub>3 at 12% CO<sub>2</sub>

	Total PCDD/PCDF	California Measured	DOHS Detection Limit	Swedish Measured	Detection Limit	Measured	EPA Detection Limit
Commerce Refuse							
Stack, Test 15	.79	.001	.047	.0005	.018	.0012	.009
Stack, Test 16	<u>1.14</u>	<u>.007</u>	<u>.051</u>	<u>.0014</u>	<u>.019</u>	<u>.0018</u>	<u>.010</u>
Avg.	.97	.004	.049	.001	.019	.0015	.010
Residential Refuse							
Boiler Exit	28.5	2.05	2.15	.738	.835	.287	.381
Stack	3.5	.076	.125	.023	.045	.014	.024
Reduction %	88	96	94	97	95	95	94

TABLE 8

## SUMMARY OF METALS MEASUREMENTS AT BOILER EXHAUST AND STACK

Location Test	Boiler Exhaust			Stack		
	13	14	Avg	11	13	Avg
Gas Temp, °F	499	504	502	256	278	267
Gas Flow, dscfm	44,530	44,250	44,390	53,380	49,660	51,520
Sample gas vol, nm <sup>3</sup>	0.571	0.648	--	5.36	4.41	--
Metals Conc*, mg/nm <sup>3</sup> at 12% CO <sub>2</sub>						
Antimony	1.6-2.1	1.5-1.7	1.6-1.9	ND<0.023	ND<0.045	ND<0.034
Arsenic	0.16-0.19	0.22-0.25	0.19-0.22	ND<0.0014	ND<0.0026	ND<0.0020
Beryllium	0.0062-0.0071	0.0069-0.0077	0.0066-0.0079	ND<0.0005	ND<0.0009	ND<0.0007
Cadmium	2.7-2.3	2.0-2.1	2.4-2.7	ND<0.0023	ND<0.0045	ND<0.0034
Chromium	0.68-0.81	0.60-0.67	0.64-0.74	ND<0.0005	ND<0.0009	ND<0.0007
Copper	5.8-7.0	4.1-4.5	5.0-5.8	ND<0.0028	ND<0.0054	ND<0.0041
Lead	43-53	42-48	43-51	0.0029-0.0051	0.0012-0.0033	0.0021-0.0042
Mercury	0.58-0.68	0.21-0.24	0.40-0.46	0.14-0.20	0.39-0.95	0.27-0.58
Nickel	0.65-0.78	0.52-0.59	0.59-0.69	ND<0.019	ND<0.036	ND<0.028
Selenium	0.016-0.019	0.013-0.014	0.015-0.017	ND<0.0009	ND<0.0019	ND<0.0014
Silver	0.12-0.15	0.12-0.13	0.12-0.14	ND<0.0015	ND<0.0045	ND<0.0030
Thallium	ND<0.012	ND<0.009	ND<0.011	ND<0.0019	ND<0.0036	ND<0.0028
Zinc	61-74	69-77	65-76	ND-0.08	ND-0.16	<0.05